

130TH STREET AND TORRENCE AVENUE RAILROAD TRUSS BRIDGE



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BIOGRAPHY

Diane Campione, PE, SE is a Senior Project Manager at Alfred Benesch & Company with over 32 years of structural engineering experience. She received her Bachelor of Science and Master of Science in Civil Engineering from the University of Illinois at Urbana-Champaign. Since then she has co-written numerous research papers, including a paper on earthquake analysis for the Council on Tall Buildings and Urban Habitat, as well as a paper on the analysis of bridge piers for scour conditions for the University of Illinois, Urbana-Champaign. She is also a member of multiple industry associations, including the American Society of Civil Engineers and the Society of American Value Engineers. She served as Project Manager on the design of the 130th Street and Torrence Avenue Railroad Truss Bridge project.

Elissa Ship, PE, SE is a Project Manager at Alfred Benesch & Company with over 16 years of experience in structural engineering. She received her Bachelor of Science and Master of Science in Architectural Engineering from the University of Illinois at Urbana-Champaign. She has contributed to the successful completion of numerous projects providing designs and general project oversight for roadway and railroad bridges, culverts, retaining walls and noise abatement walls. She served as Project Engineer on design of the 130th Street and Torrence Avenue Railroad Truss Bridge project.

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Chicago Department of Transportation – Division of Engineering, where he manages all phases of bridge and roadway projects. He is an Adjunct Professor at Illinois Institute of Technology (IIT), where he teaches Transportation Facilities Design, and F.E. and P.E. review courses. He is an Associate Editor of Practice Periodicals on Structural Design and Construction, an ASCE publication. He is also a member of the Board of Directors of the Structural Engineers Association of Illinois. He received his Bachelor, Master, and Doctoral degrees in Civil Engineering-Structures from IIT, Chicago.

SUMMARY

The success of a \$101 million intersection reconstruction project largely depended on the efficient design and construction of a new commuter railroad bridge. This was achieved by the use of innovative Accelerated Bridge Construction (ABC) techniques including the construction of a 394-foot, 4.75-million-pound steel railroad truss in a staging area which was then rolled into place in a matter of hours using Self-Propelled Modular Transporters (SPMTs), which are large wheeled platforms that can move and lift immense loads at millimeter precision.

It took just four months to assemble and paint the structure, which consists of 25,000 pieces of steel held together by 65,000 bolts. The efficiency of the truss move allowed the Norfolk Southern Railway and Torrence Avenue to reopen ahead of schedule, eliminating the need for further detours and delays.

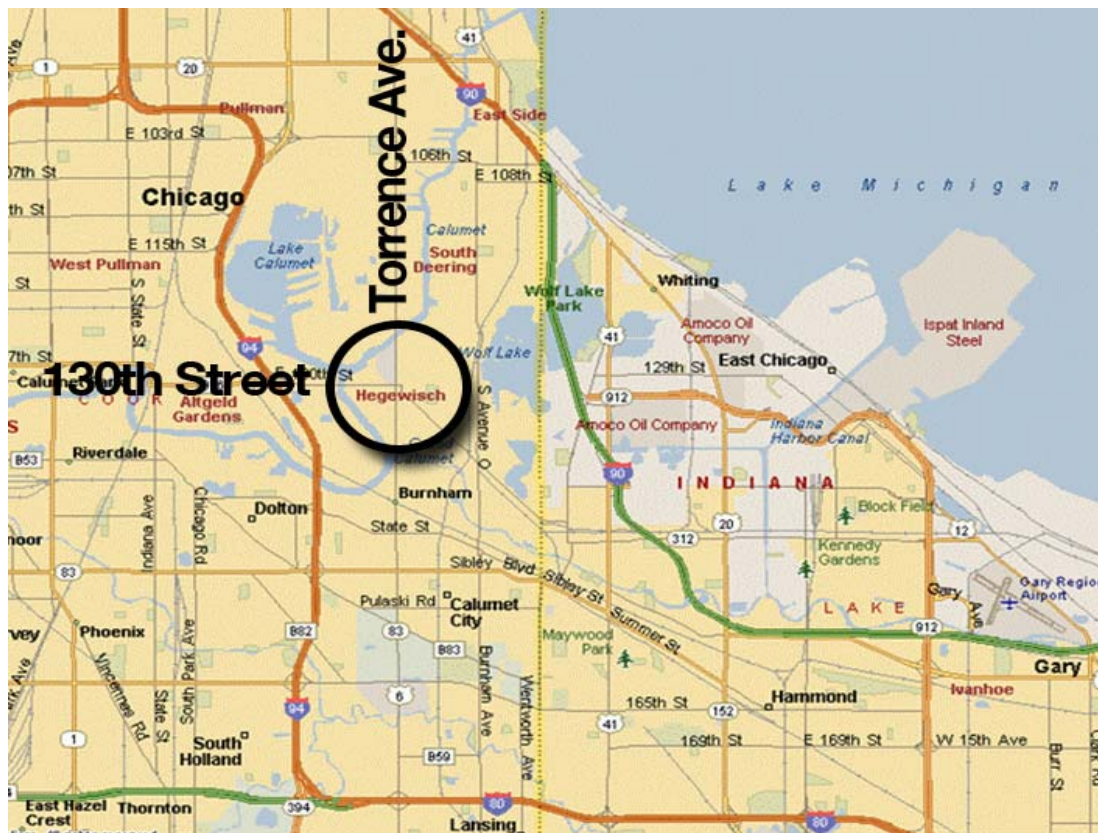
130TH STREET AND TORRENCE AVENUE RAILROAD TRUSS BRIDGE

Introduction

Eight years in planning resulted in the successful roll-in of the largest steel railroad truss. On August 25, 2012, a multi-level grade separation designed by Alfred Benesch & Company (Benesch) not only hit a major project milestone, it made history when the 394-foot-long, 4.75 million pound steel railroad truss bridge was safely rolled into place. Innovative Accelerated Bridge Construction (ABC) techniques were utilized to transport the steel truss 800 feet from its staging area to its final position in less than four hours. The commuter-freight rail truss, believed to be the largest steel truss railroad bridge span ever rolled into place, now makes a striking silhouette as construction continues at the project site. In the following sections, the authors will discuss the need for the truss, the evolution of its configuration from

the preliminary design stage to the final design stage and the use of accelerated bridge construction techniques as means to facilitate construction of the truss with minimal impacts to the operating railroads and motorists.

The new railroad truss replaced an existing Chicago, South Shore and South Bend (CSS&SB) Railroad bridge and is a key component of the 130th Street and Torrence Avenue intersection improvement project, an extremely complex, \$101 million effort by the Chicago Department of Transportation (CDOT) as part of the Building a New Chicago Infrastructure program. This area, located on the far southeast side of Chicago (see *Figure 1*), serves approximately 38,000 vehicles per day and over 50 freight trains cross on at-grade Norfolk Southern



Railway (NS) tracks nearby at 130th and at Torrence Avenue and is further complicated with the recent expansion of the adjacent Ford Motor Company Manufacturing Campus. Full project completion is expected in 2016, but design, construction and the roll-in of the steel railroad truss has already garnered significant attention. When completed, this project will relieve traffic congestion and improve rail service efficiency in this area.

Eliminating conflicts caused by two at-grade railroad crossings resulted in realigning and depressing 130th Street and Torrence Avenue below the existing Norfolk Southern Railroad (NSRR) tracks. The existing CSS&SB tracks are supported over the existing NSRR at Torrence Ave and carries over 40 passenger trains each day. Making sure all the project components fit in this complex puzzle while maintaining all rail traffic required the CSS&SB railroad truss span to be constructed first.

During the early stages of final design, alternatives were identified for the assembly and erection of the CSS&SB truss span. Results of the evaluation analysis demonstrated that the assembly of the truss in a staging area and then transporting the truss using Self Propelled Modular Transporters (SPMTs) was a cost effective solution. In the end, the existing CSS&SB elevated structure was replaced with a new 394 foot long truss that became the longest and heaviest railroad truss ever moved into place with the use of self-propelled modular transporters (SPMT's).

The completed project will consist of a three-tiered grade separation, including a total of six new bridges (railroad (3), roadway (1) and pedestrian/bicyclist bridges (2)); a mixed-use path; over 9000 linear feet of retaining walls; a new drainage system (including underground detention chamber and pump station); street lighting; traffic signals; roadway pavement; extensive landscaping and more.

The project offered Benesch, CDOT and rail engineers a complicated three dimensional puzzle to solve, with the final solution requiring all aspects of the civil engineering profession. It also required an

intricate and complex construction sequencing plan and outstanding team work from all stakeholders.

Background

The new steel railroad truss replaced the original bridge that entered into service in 1909. This bridge and rail line is owned by the Chicago South Shore and South Bend Railroad (CSS&SB) and maintained and operated by the Northern Indiana Commuter Transportation District (NICTD). The CSS&SB tracks carry both freight trains as well as the Northern Indiana Commuter Transportation District's (NICTD) commuter rail line that brings commuters from South Bend, Indiana to downtown Chicago.

The Ford Motor Company Chicago Assembly Plant (CAP) has been the dominated industrial activity generator on the southeast side of the City of Chicago. Recognizing the present road infrastructure configuration and its at-grade rail crossings would be inadequate to support growing traffic demands expected with Ford's planned CAP expansion and the development of the Chicago Manufacturing Campus, the Chicago Department of Transportation (CDOT) began, in the mid 1990's, the preliminary engineering for a project that would address significant traffic congestion issues at the intersection of 130th Street and Torrence Avenue.

CDOT identified three main objectives to be addressed by the proposed project. The first would be to eliminate delays, minimize conflicts and interruptions to traffic associated with two at grade railroad crossings located on the site. The second objective was to improve traffic flow for the commercial and industrial traffic through the area by providing a direct connection between 130th Street and Brainard Avenue. The last objective of the project would be to reconstruct Torrence Avenue so that it can accommodate heavy truck traffic and Ford's new supplier handling procedures. An overall view of the existing site configuration can be seen in **Figure 2**. The Ford CAP is located to the north and west of 130th Street and Torrence Avenue.



Figure 2: Conditions before construction

The intersection of 130th Street, Torrence Avenue and Brainard Avenue serves approximately 38,000 vehicles per day with 15% of that volume comprised of trucks. Many of these trucks are supplying parts necessary for the operation of the CAP. The existing alignment of the NS tracks cross both 130th Street and Torrence Avenue with at-grade crossings. The CSS&SB rail line runs through the site on an elevated curved structure to the south of 130th Street and Brainard Avenue. The two rail lines serve approximately 50 freight trains and 41 passenger trains per day. With this amount of rail traffic combined with the heavy truck traffic, the two at grade crossings cause significant traffic delays. Under the existing conditions, the at-grade crossings can be blocked for as much as 25 minutes at a time with 10 minutes as the average blockage time. This substantial blockage of both 130th Street and Torrence Avenue leads to an intersection with a substandard level of service. **Figure 2** shows the configuration of roads and rail lines before any construction took place.

The solution to resolve the significant traffic congestion issues and eliminate the conflicts at the

two at-grade crossings required grade separating the NS tracks and 130th and the NS tracks and Torrence Avenue. To accomplish this separation required depressing the roadways under the NS railroad. Two new railroad bridges are constructed at 130th and at Torrence Avenue. Maintaining rail traffic during construction requires the realignment of both the NS and CSS&SB railroad tracks. Re-alignment of the NS tracks to the east of its existing alignment required the new CSS&SB truss to be constructed first on its new alignment just south of its existing alignment. To create a more efficient 130th Street to Brainard Avenue connection required 130th Street, west of Torrence Avenue, to be shifted approximately 50 feet south of its existing alignment. This shift enhances the options for staging and maintenance of traffic; it also allowed some utilities to remain in the north half of the existing 130th Street and enabled a direct and continuous connection of 130th with Brainard Avenue. At project completion, 130th Street/Brainard Avenue will form an at-grade intersection with Torrence Avenue.

In the depressed sections, retaining walls are required because of limited right-of-way and

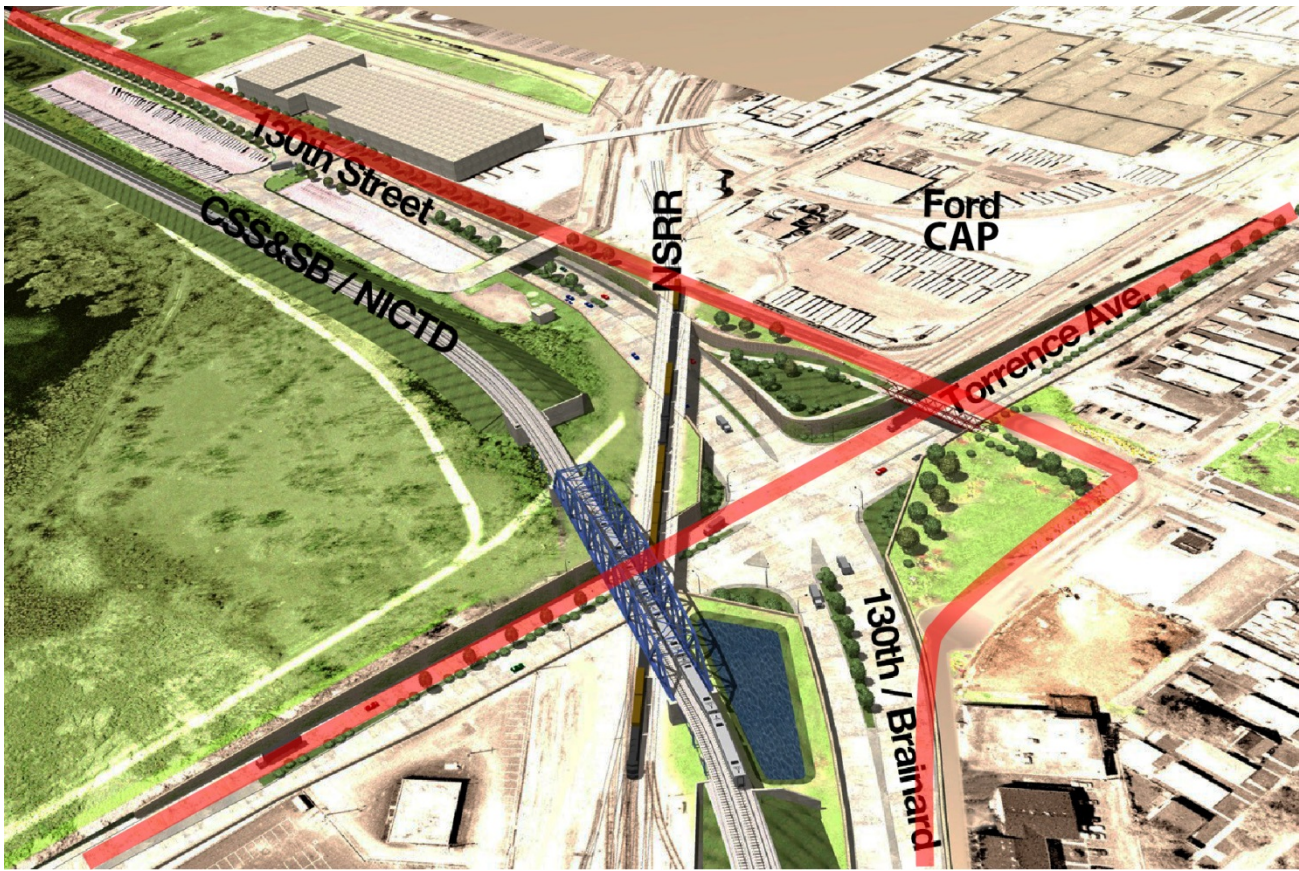


Figure 3: Rendering of completed project

drainage concerns due to the high groundwater. To the west and north of the project is Little Lake Calumet and just southwest of the project site is the Hegewisch Marsh, a premiere site for wetland birds. There are about 9,000 feet of permanent retaining wall structures. The depressed new roadways require a new drainage system, complete with a detention chamber, located below 130th street, a 9000-gpm triplex pumping station and settling basin to manage the storm water. See **Figure 3** for a rendering of the completed project.

Need for a Truss

The new CSS&SB steel railroad truss is a key component to this complex project, and there were numerous project challenges to overcome during the design phase. The proposed solution had the realigned 130th and Torrence intersection depressed 28 ft. with both roads under the NS railroad. To minimize disruption of the NSRR train traffic during construction of the new roadways requires the two new NS railroad bridges to be constructed on offset alignment. The new track alignment was constrained

by the existing track alignment at the project limits: the NS Mixing yard to the south and the Ford Motor Company to the north. The realigned NS tracks created a conflict with the location of the existing supports for the elevated CSS&SB structure that runs a sweeping arc through the site above the NS tracks and Torrence Avenue. Thirteen (13) existing piers touched down at various skews along the existing CSS&SB alignment. To accommodate the new NS track alignment required the replacement of the existing CSS&SB elevated structure. **Figures 4 and 5** show the existing substructures of the CSS&SB elevated structure over the major elements the structure crossed.

The truss location and geometry established during the Phase I - Preliminary Design was based on satisfying the following needs and constraints:

- Minimize impacts to the RR operations during construction (both railroads need to remain in service)
- Meet NS horizontal and vertical requirements at both the existing and proposed alignments



Figure 4: CSS&SB over NS tracks



Figure 5: CSS&SB over Torrence Avenue

- Tie back into the CSS&SB existing tracks while accommodating the track spiral
- Accommodate the proposed widened and realigned Torrence Avenue

preliminary layout of the CSS&SB truss. The 14'-0" minimum horizontal clearance to the existing and proposed tracks were the pinch points used to locate the abutments. The 45 degree skew was implemented to have the shortest span possible.

A clear spanning structure was determined to be the most feasible alternative; and at the end of preliminary design, the proposed CSS&SB structure consisted of a 368' long truss with abutments skewed at 45 degrees. **Figure 6** shows the

Evolution of Truss Design

During the early stages of the final design phase, other geometric and logistical constraints by the site and stakeholders surfaced, requiring the geometry of

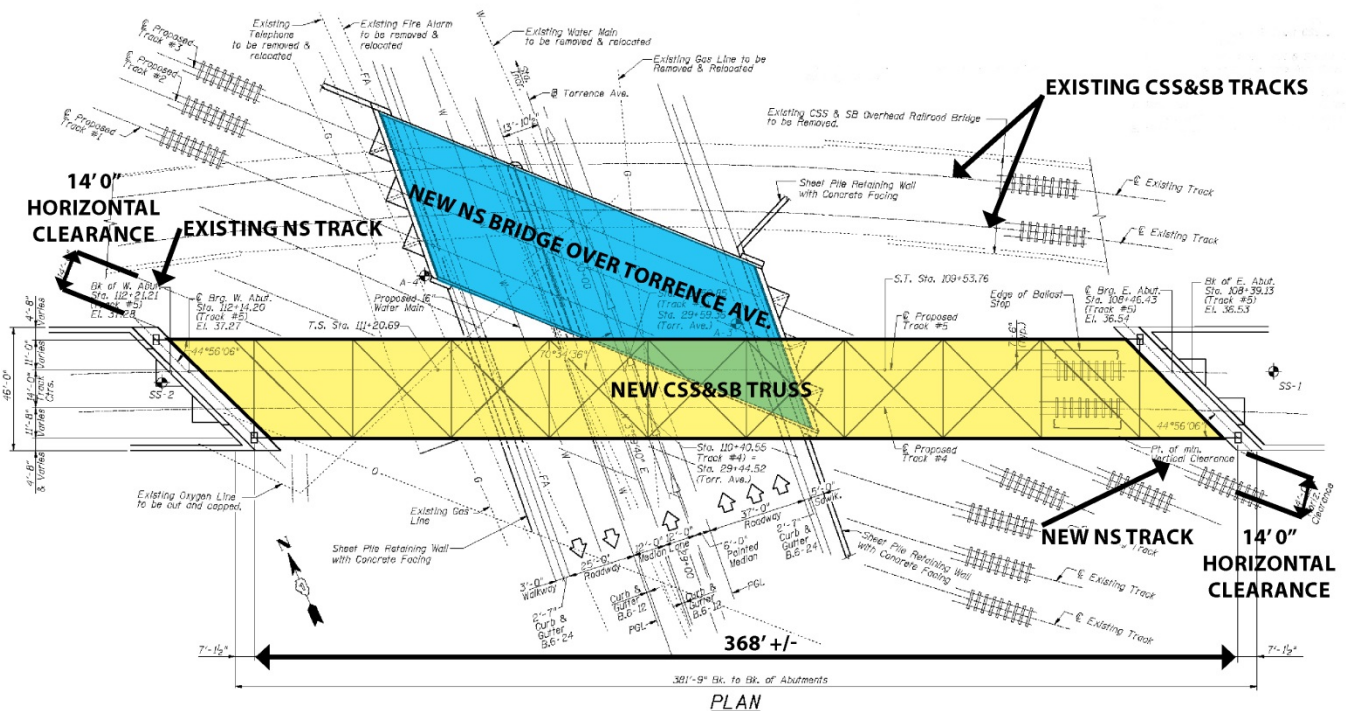


Figure 6: Preliminary layout of CSS&SB Truss

the truss to be revisited. The design team was challenged to explore options to improve on the truss assembly and the construction efficiencies. The detailing and fabrication of the skewed portal frames of the truss were found to increase the cost of the truss and make fabrication and construction more complex. Significant impacts to the vehicular and rail traffic during construction along with extended construction schedule lead the project team to investigate the use of Accelerated Bridge Construction (ABC) techniques. Building the massive truss span in a nearby staging area and transporting the structure using Self-Propelled Modular Transporters (SPMTs) was found to be a more feasible option that would ultimately shorten the construction time to build the truss and minimize the impacts to the NSRR freight service operations and the vehicular traffic along Torrence Avenue with limited closures; resulting in reduced construction costs.

The assembly of the skewed truss structure would have been more difficult to build than one with squared ends. Not only would the skewed truss entail additional fabrication and costs, but with the truss at an angle, the SPMTs would have to guide the truss into place while moving on a diagonal.

Detailing and fabrication of the skewed truss could add 15% premium to the fabrication cost. This premium is a result of the complex geometry of the portal frames and the loss of economy in the fabrication of the end segments of the floor system. The portal frame members connect into the end post at skewed angles and will require very thick bent gusset plates. The end panels of the floor system results in the detailing and fabrication of each individual stringer of which there are 10 units. The end floorbeam connection into the bottom truss chord will be a very complex connection due to the skew and large loads requiring support at those locations. The assembly of the skewed truss structure would result in additional costs for erection given the additional time required to line up and plumb the end portals. The proposed method of erection required the complete assembly of the truss and floor system at a site southwest of the final bridge location. The SPMTs would then roll the truss into place. This task is simplified greatly if the

SPMT's only have to move in a straight line to land the truss.

The elimination of the skew also had two other advantages beyond the impacts to the steel and installation. The volume of concrete required at the abutments could be reduced by approximately 30 percent due to the reduced width of the abutments. The end floorbeam span would also be reduced from approximately 57'-8" to 40'-2", eliminating the need for an intermediate bearing for the floorbeam. The revised and final layout of the truss resulted in a 394' span center to center of bearings with supports perpendicular to the structure.

The longer truss span required the east abutment to shift a couple feet to the east due to an increase in bearing size from the sized estimated during preliminary design. This shift brought the track closer to the truss due to the spiral curve at the end of the truss span (see **Figure 7**). Because of this, Benesch had to make sure the bridge was wide and tall enough to meet the railroad's clearance requirements. The width of the truss increased from 36'-8" to 40'-2" center to center of trusses. Another complexity was making sure the chord truss would not encroach in the AREMA clearance diagram (see **Figure 8**). The preliminary design used parallel top and bottom chords which with the revised geometrics was found to encroach in the AREMA clearance diagram by approximately 2½ inches (see **Figure 9**). An arched chord truss with similar geometrical dimensions eliminated this encroachment (see **Figure 10**). By changing the profile of the top chord to have a camelback or arched profile, the forces in the truss members were optimized and resulted in 45 tons of less structural steel. The arched top chord profile is also consistent with two nearby truss spans carrying 130th Street and the CSS&SB tracks over the Calumet River.

The end result is a truss that spans 394 feet and is a maximum of 67'-4" center to center of top and bottom chords at its tallest point. The truss substructure consists of full height concrete piers supported on driven steel piles. Excavation support system was required to protect the existing NS tracks during construction of the new piers. **Figure 11** shows the final configuration of the truss span.

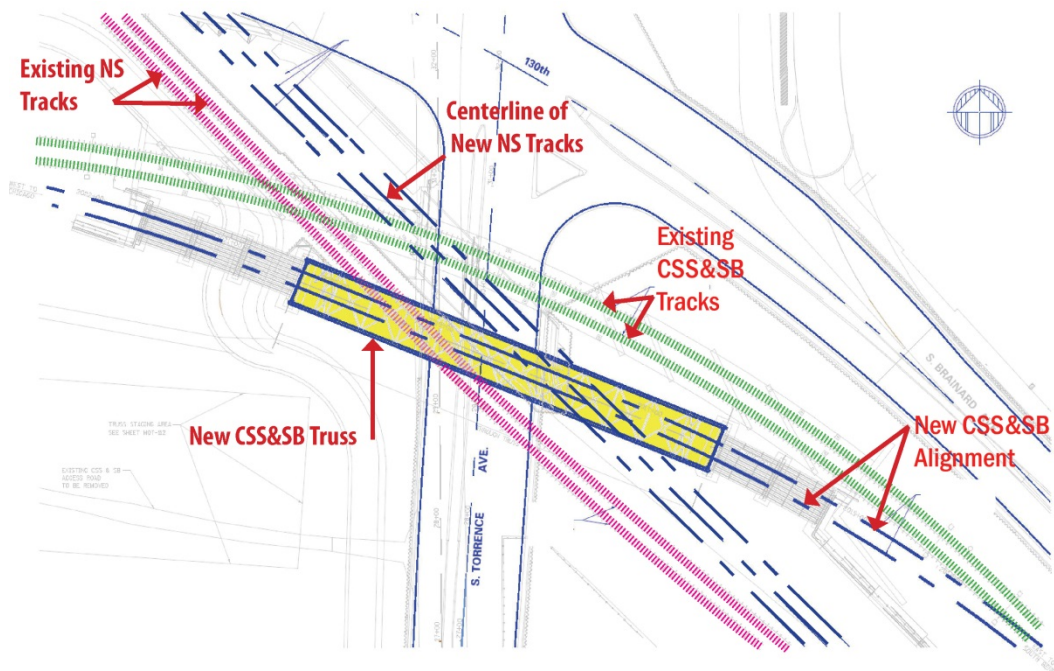


Figure 7: Horizontal clearance constraint

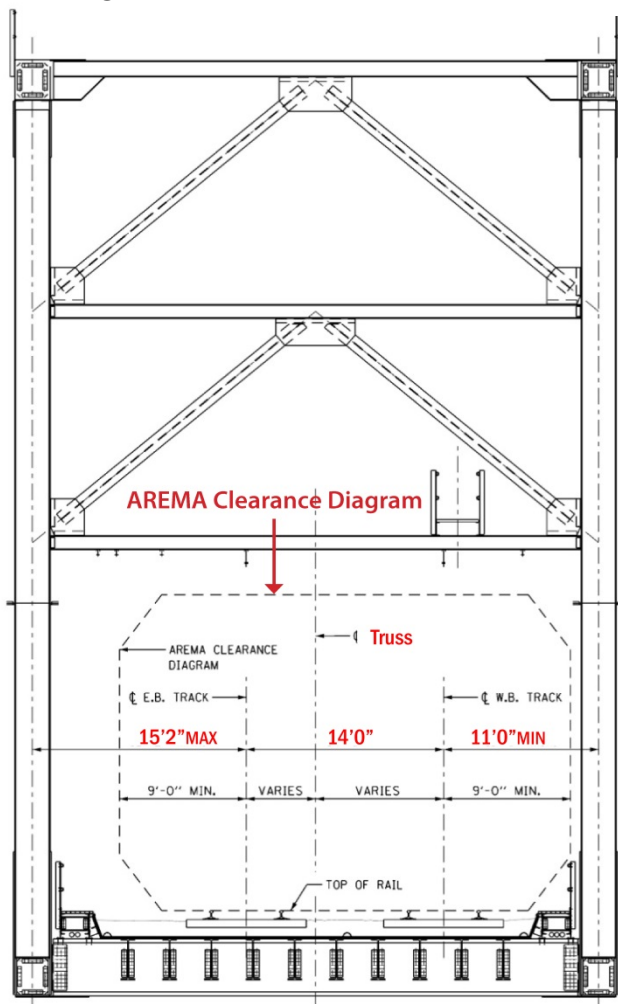


Figure 8: Cross section Sway Frame

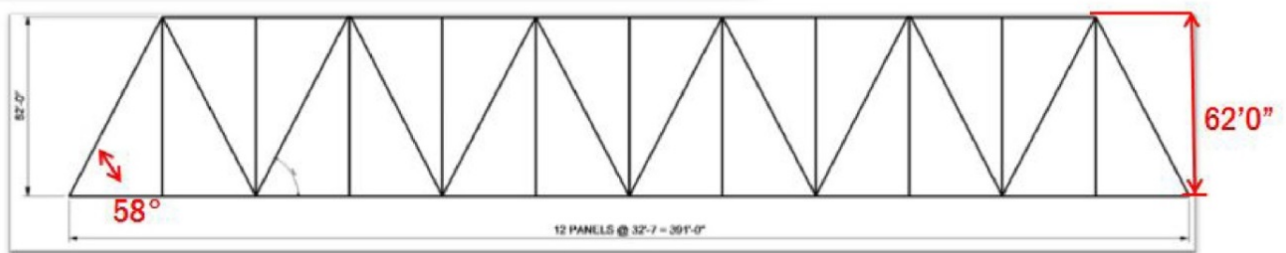
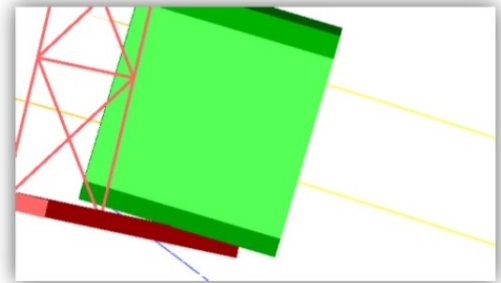
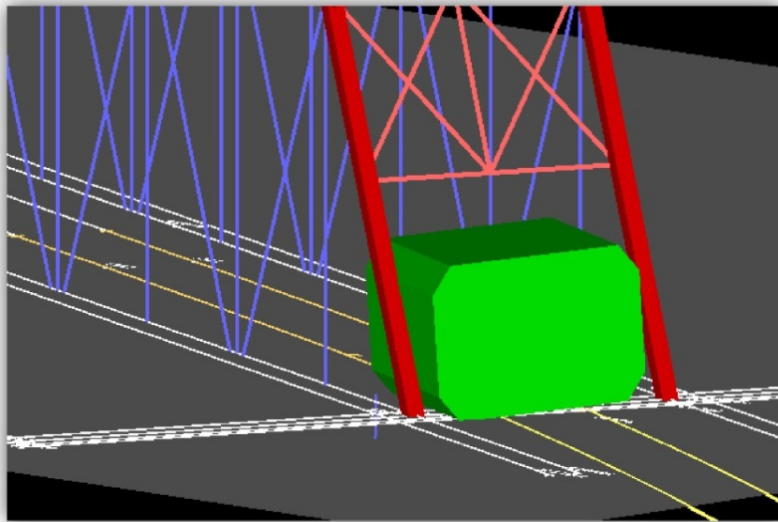


Figure 9: Parallel top chord – 2 ½ inch encroachment

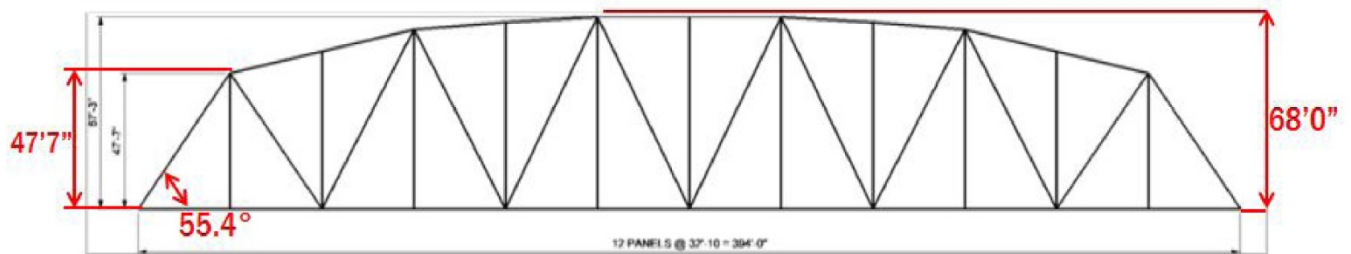
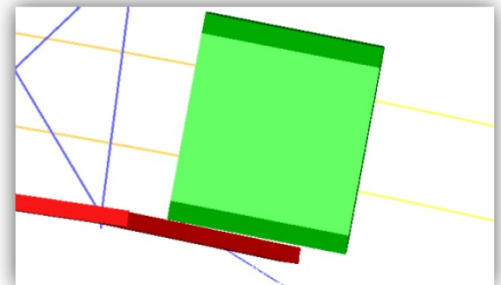
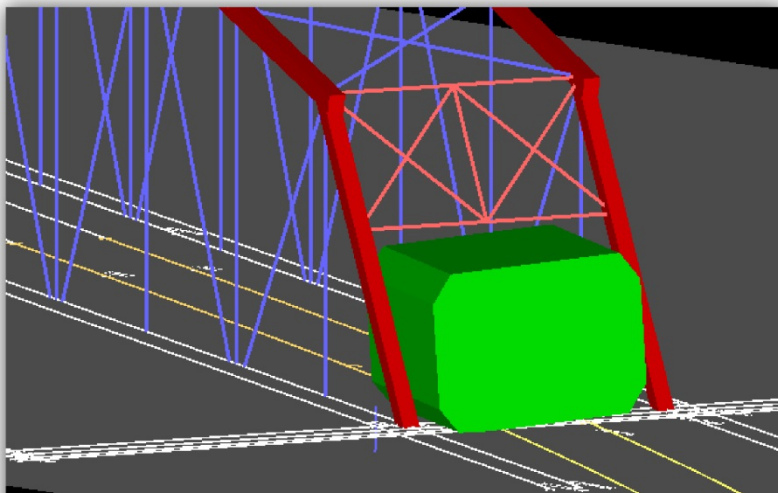


Figure10: Arched top chord – no encroachment

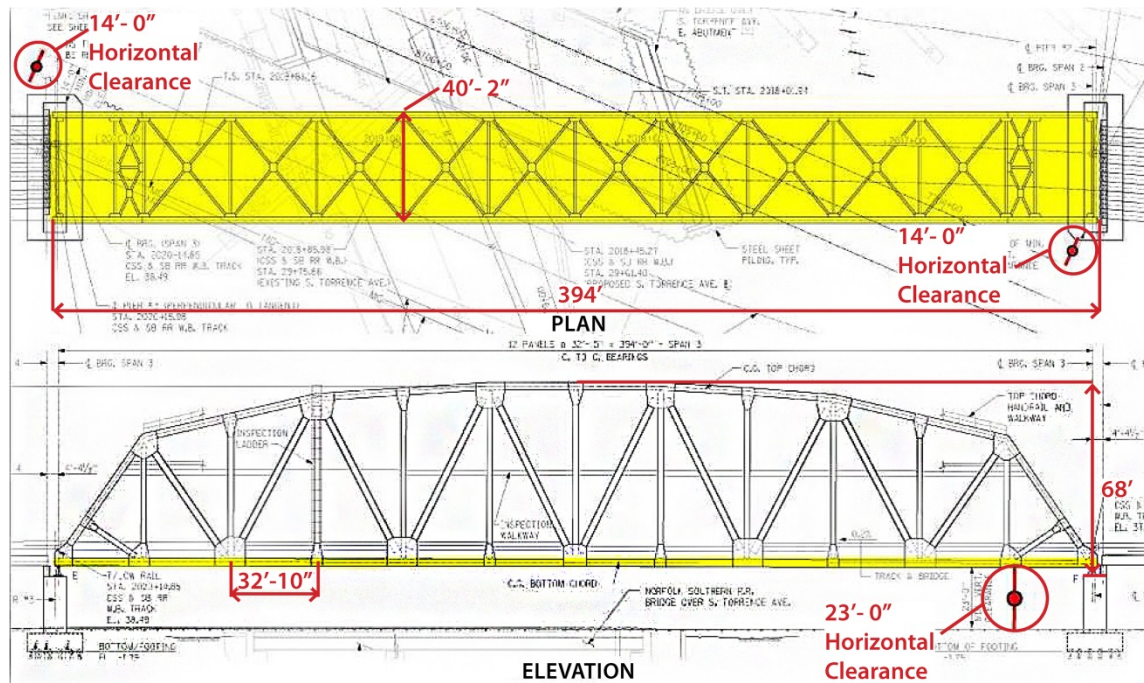


Figure 11: Final plan and elevation of CSS&SB truss

Truss Design Criteria

The truss, a double track, ballast deck structure, was designed to support Cooper E-80 live load and other design provisions in accordance with the American Railway Engineering and Maintenance of Way Association (AREMA) Manual. A summary of these design provisions follows:

1. Serviceability criteria of limiting live load deflection of $L/640$; included provisions for 12 inches of ballast (8 inches current + 4 inches future)
2. Impact Loads
 - Eccentric load on the truss due to the spiral and super-elevation that resulted in additional 10.4% more load on the truss (see **Figure 12**)

Rocking effect which is an impact load created by the transfer of load from the wheels on one side of a car or locomotive to the other side from periodic lateral rocking of the equipment. 20% of the wheel load is applied downward on one rail and upward on other rail resulting in a 2.5%

increase to the impact load (see **Figure 13**).

- Total impact load is the sum of the vertical and rocking effects reduced by 10% as AREMA allows for reduction for ballast conditions.
 - Total impact is $18.14\% = (17.65\% + 2.5\% (\text{rocking effect})) \times 0.90$
3. The centrifugal force must also be accounted for since the tracks are on a spiral at each end of the truss (**Figure 14**)
 - $= 0.00117 S^2 D$; Where $S=35$ mph and $D=4$ degrees
 - Results in 3.38% increase to live load
 4. Nosing force are lateral forces due to equipment; 25% of wheel load is applied at the rail base which results in an additional load of 1.6 kips to each internal panel point (see **Figure 15**).
 5. Other unusual forces include the large longitudinal forces from braking and traction due to stopping and starting of the trains. The larger of the two values presented below is resisted by the tracing bracing located in the plane of the stringers.

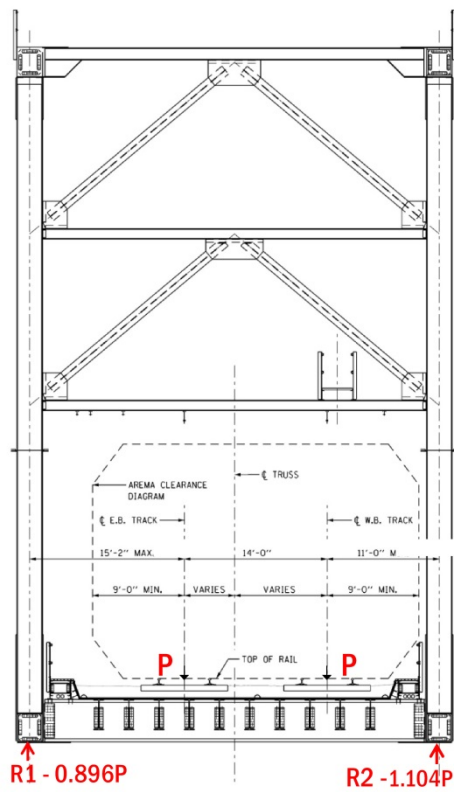


Figure 12: Eccentric load on truss

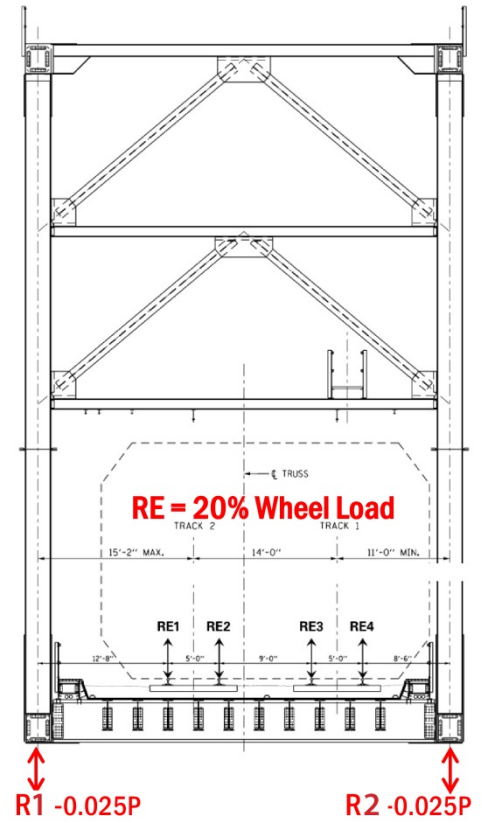


Figure 13: Rocking effect

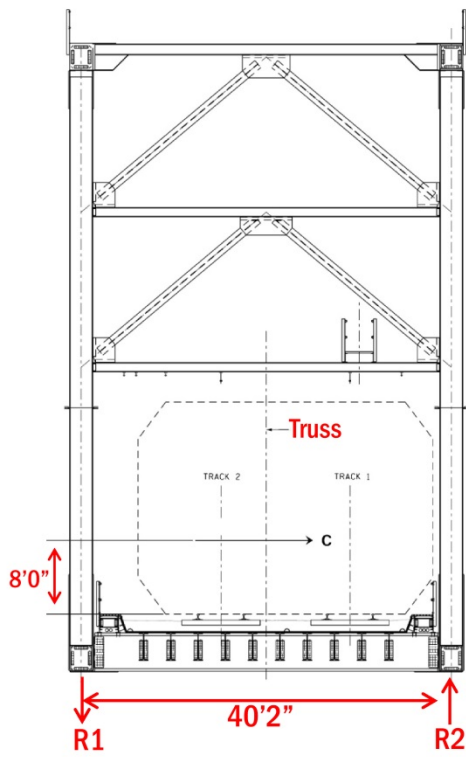


Figure 14: Centrifugal Force

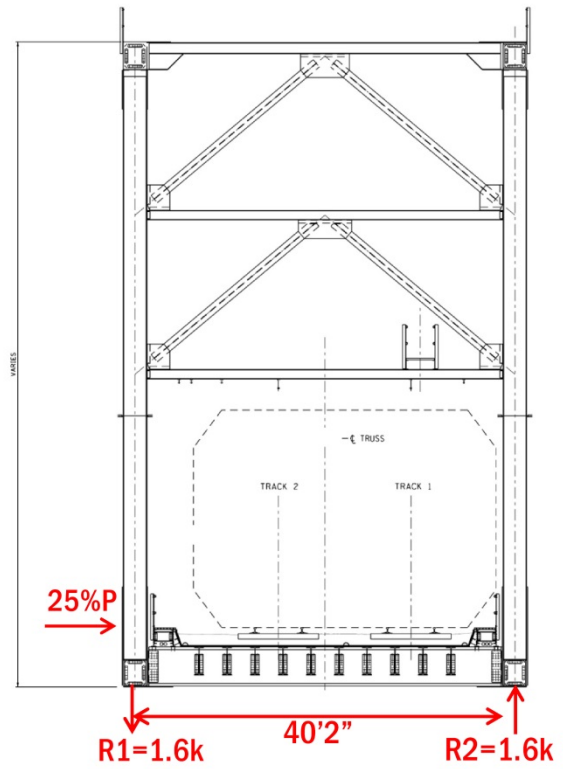


Figure 15: Nosing Force

Loads calculated are per track and includes eccentricity factor (10.4%)

- Breaking 45+1.2L @ 8ft above t/rail
 - Tracking: 25√L @3ft above t/rail
 - Larger of the two values
 - Loads calculated are per track and includes eccentricity factor (10.4%)
6. Other lateral loads are those due to wind
- Unloaded Truss
 - 50 psf of surface (windward and leeward)
 - Loaded Truss
 - On train: 300 lb/ft on one track, applied 8 feet above top of rail
 - On truss: 30 psf (vertical projection of the span + any portion of the leeward trusses not shielded by the floor system)

The truss bearings were designed for the following conditions and forces:

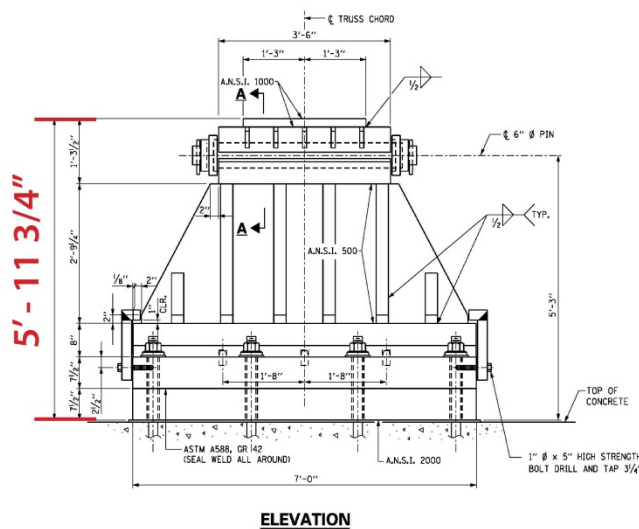
1. Expansion and contraction (temperature):
1 ¼ inches per 100 ft., which for 394 ft. length results in 5 inches at 50 degrees
2. Jacking provisions at the end floor beams
3. Lateral forces
4. Longitudinal braking force of 519 kips per track governs, which is resisted by the fixed bearing

These forces as seen in **Figure 16** resulted in fairly large bearings: the expansion bearings are nearly 6 feet tall and fixed bearings are just over 4 feet.

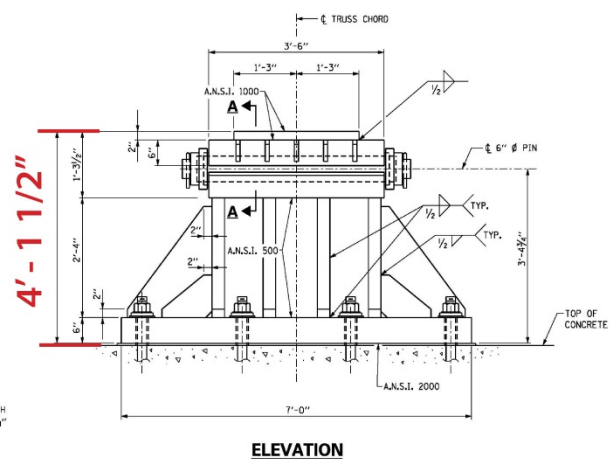
Grade 50 steel was used for the beams and girders which were 50 inches deep made up of 1.5 inches x 43 inches web plate and 3 ½ inch thick flange plates. The top and bottom chords are box members that are 34" high and 30" wide. The web members are a combination of I-shaped members for the posts, hangers and more lightly loaded diagonals and box shaped members for the highly stressed diagonals and portal frame. To keep plate sizes of the box chords to reasonable thicknesses, Grade 70W HPS steel was used for the most highly stressed members. The maximum plate thickness of any box member is 2.25 inches. To facilitate inspections, handholes were spaced every 6 feet and detailed with bird screens.

The truss was cambered for Dead Load (actual) plus 3000 lb./ft. (for each track) which resulted in a 5 ½ inches at midspan. The load combination of DL+LL+I+CF controlled member sizes. Fatigue controlled the tension member size:

- 50 ksi members (wt = 0.80 kips/ft)
 $f_{\text{fatigue}} = 14.56 \text{ ksi} < f_{\text{allow}} = 16 \text{ ksi}$
- 70 ksi members (wt = 0.73 kips/ft)
 $f_{\text{fatigue}} = 15.81 \text{ ksi} < f_{\text{allow}} = 16 \text{ ksi}$



Expansion Bearing
Wt = 35,800 lbs



Fixed Bearings
Wt = 17,800 lbs

Figure 16: Truss bearings

The truss has an inspection walkway system to allow inspectors to safely access the majority of the members of the truss. At deck level there are two 2'-3" walkways, one on each side of the truss. A walkway that is accessed by a caged ladder system spans between each bottom horizontal member of the sway frames which are about 28' above track level allowing for better visual inspection of the upper parts of the truss. The last components of the inspection system are two walkways located along the top chords of each truss with a crossing located at the middle panel point to get from one top chord to the other. **Figure 8** shows a cross section of the truss at mid-span.

Although it would appear that the longer spanning truss would be significantly more expensive than the design at the end of preliminary design, the benefits gained from simplifying the geometry, reducing abutment lengths and optimizing the steel shapes using Grade 70 steel resulted in significant savings. A longer truss span with squared abutments would provide a more economical design but it also made the ABC techniques a feasible alternative compared to assembling (stick building) the truss in place over an active railroad and busy urban roadway. Stick building construction would have added significant safety risks to the construction workers and would have added an estimate five to six months of additional construction time. Assembling the truss in a staging area kept construction separated from rail and vehicular traffic and gave the contractor much more flexibility in terms of construction operations and schedule. As a result, the construction team focus remained solely on the assembly of the truss rather than needing to accommodate the rail and vehicular/truck traffic. The staging area offered more opportunities for uninterrupted work which resulted in a more consistent overall quality of the finished product.

In retrospect, it seems the idea of rolling in the truss would be a win-win situation for all given how seamlessly the roll-in went. This was not the case back in 2003 when the idea was first evaluated. CDOT and Benesch held a value engineering workshop to determine the best alternative for assembly and erection of the truss. Twenty five ideas were speculated, grouped into alternatives and evaluated for performance and acceptance. At the conclusion of the workshop two alternatives were

fully developed and evaluated; build in place and stage assembly/roll in the truss (ABC techniques). Each alternative had major benefits and significant limitations. The major advantages of building the truss in place included using standard construction technology which had higher acceptance to the stakeholders at the time, minimal environmental impacts to the Hegewisch marsh and not having to use full closures of Torrence Avenue or the NS tracks. The major advantages of the ABC techniques (truss roll-in) included less impacts to NS operations, contractor control over the erection schedule, shorter assembly time and the City was able to leave two lanes of Torrence Avenue open at all times. The major limitation of the roll in option was the requirement to shut down the NS tracks for a continuous eight hour period. A shut down of this duration carried the possibility of lost revenue and substantial risk in the event the roll-in did not go as planned. The comparative cost analysis showed a \$500,000 potential savings with the staged assembly/roll-in alternative.

In 2004 the project team met with the leaders of the NS at their headquarters in Atlanta, Georgia in an effort to convince the railroad that rolling the truss into place was a viable and cost-effective option. In order for the roll-in to occur, the NSRR tracks would have to be completely shut down for the duration of the roll-in. In the end, all parties were convinced and the NSRR granted an eight hour window in which they would allow the tracks to be shut down.

With NS concurrence to proceed with the truss roll-in, the design team prepared the contract plans and specifications to include the proper guidance for the bidding contractors to understand the proposed concept. Notable provisions in the specifications included liquidated damages of \$12,500 per hour if the installation exceeded the eight hour shutdown window and well defined submittal requirements for the truss assembly and transporting. The plan documents also included suggested plan layout of the staging area, located southwest of the final truss location and schematics for the truss transport route. Special provisions detailed the requirements for the staging area to accept the loads of all of the construction traffic, cranes and weight of the truss and requirements to bring the area back to its natural environmental pre-construction state.

Truss Roll-In

The project was advertised for bidding in September, 2010. The contract was awarded to the Walsh Construction Company (Walsh) who subcontracted with The Sarens Group to perform the roll-in. Benesch, in addition to being the designer for the preliminary and final design phases, is also the construction manager for the construction phase. All team members involved were familiar with using SPMT's to roll in larger transportation structures. In 2003, Walsh was the general contractor and Benesch was the construction manager for a project that included a roll in of a Chicago Transit Authority truss structure as part of the larger Wacker Drive Reconstruction Project. This project included the shutdown of a very busy commuter rail line for an entire weekend and also involved rolling in a truss structure that was located just a few feet away from its final location. The expertise learned from the project proved to be valuable in convincing all parties that the roll in was not only feasible, but was the best option available.

According to the contract specifications, the contractor had to have the truss in place within 489 days of the beginning of the contract. With that constraint, August 25, 2012 was the date set for the roll in.

Construction officially began in June, 2011 and the site was in the condition as shown in **Figure 17**. Since the reconstructed CSS&SB is on an offset alignment, pier and abutment construction for the truss and approach spans could begin immediately. By December 2011, the foundation structures were complete as shown in **Figure 18**. In May 2012, the truss assembly began in the staging area as shown in **Figure 19** which also shows the close proximity of the staging area to the final location of the truss. During assembly, the truss was supported at L0, L2, L4, L6, L8, L10 and L12 as detailed in **Figure 20**. By mid-August 2012, the truss was assembled, painted a signature blue. Right before transferring the truss to the SPMTs, the truss was jacked onto temporary supports (@ L2 and L10) detailed in **Figure 21**. **Figure 22** shows the jacking operations at L2. Two operators controlled the hydraulic jacks and were in communications to lift all four points the same amount at same time. **Figure 23** shows one of the operators. With the truss jacked, the SPMTs

were positioned under the truss, each supporting one line of the truss at L3 and L4 and at L8 and L9 as shown in **Figure 24**. Local joint strengthening reinforcement was incorporated at L3 and L9 for support on the SPMTs (see **Figure 25**). With the truss supported on the SPMTs, it was ready to make its 800-foot journey from the staging area to its final location.

In preparation of the August 25th roll-in, Walsh prepared a detailed schedule for the 8 hour window that was divided into 15 minute increments and detailed where each crew was to be and what task had to be accomplished. Beyond just rolling in the truss, there was additional work that had to be completed within the eight hour window.

This work included the dismantling of the crossing gates and signals, laying a temporary crossing over the NS tracks for the SPMT's to traverse and removing and reinstalling these items after the truss was moved into place.

On the Friday night before the move, Torrence Avenue was closed to traffic and the truss was moved 150 feet to the edge of the roadway. The specifications allowed for the truss to be brought within 25 feet of the centerline of the southernmost NS track before the move. The truss was supported by four SPMT units as shown in **Figure 26**. Each unit consisted of 96 individually computer controlled wheels capable of rotating a full 360 degrees. All totaled there were 384 wheels controlled by a single operator using a joystick that would not appear too much different than that of a remote controlled toy car. The SPMT's were also capable of lifting and lowering the truss which eliminated the need for any cranes which are limited to a fixed location as well as lifting capacity. Moving the truss the night before the eight hour shutdown allowed for a practice run to make sure the SPMT's were operating as planned.

The closure of the NS tracks began at 8:00 am on Saturday morning, the truss first moved 450 feet east then the SPMT's pivoted and turned north and traveled another 200 feet north to its location just inches above its final support location. It took two hours to get the truss lowered onto the pier and another two hours to get the bearings adjusted properly. **Figures 27** and **28** shows the SPMTs

moving the truss over the NS existing tracks and towards the new truss piers. The SPMT's were removed and the track signals and crossing restored well within the eight hour shutdown window. **Figure 29** shows the new truss alongside the existing bridge. Shifting the CSS&SB on a new alignment and utilizing accelerated bridge construction techniques allowed commuter rail service to remain operational during assembly and installation of the truss.

At the time of this paper, construction on the project is still ongoing and the project is expected to be complete in mid to late 2015.

Dozens of people were on hand with active roles to play on the day of the roll-in. While the actual act of controlling the SPMT's was performed by one person, it was a very well-coordinated effort with constant communication between crew members up high on the piers or down on the ground. The success of the roll in was due to the close coordination between numerous parties and the dedication of all to meet the required deadlines.

Once the truss was in place, the contractor and railroad forces could continue work that included placing the ballast and ties on the truss, installing the catenary wires that power the NICTD trains and putting the finishing touches on the truss. On October 25, 2012 the first NICTD train crossed the truss and the moment was captured in the picture shown in **Figure 30**.



Figure 17: June 2011 - Site Prior to Construction



Figure 18: December 2011 - Foundation Units in Place for Truss and Approach



Figure 19: May 2012 - Truss Assembly Begins; Approach Spans in Place

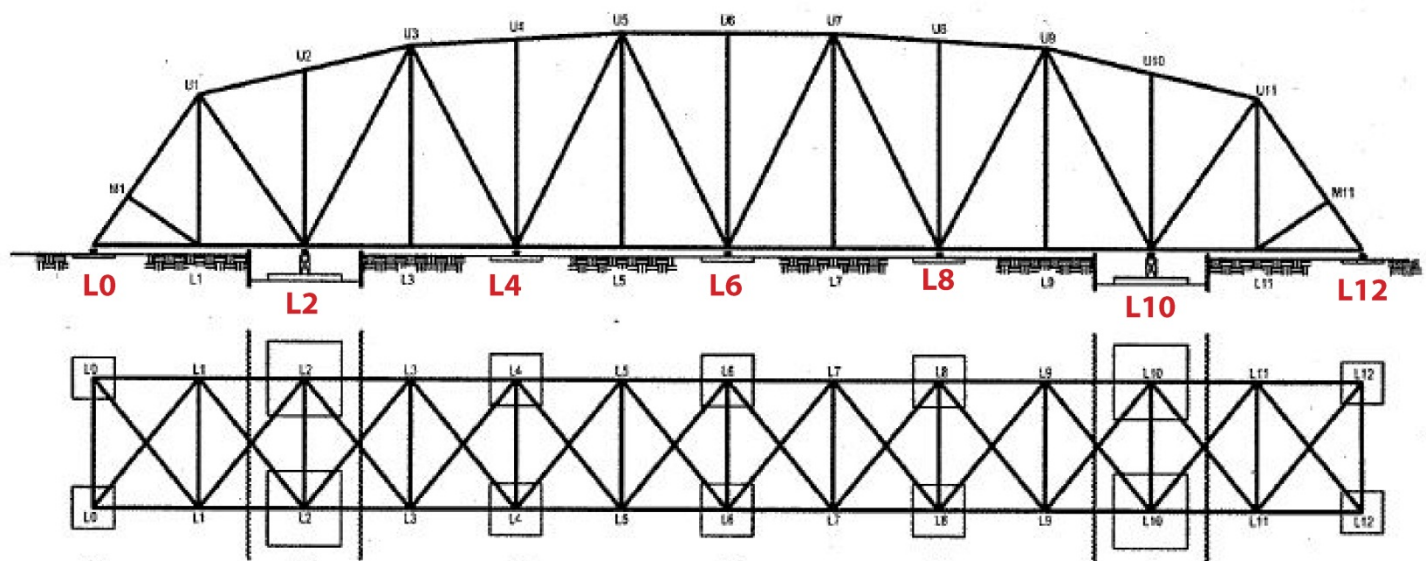


Figure 20: During assembly temporary foundation supports at L0, L2, L4, L6, L8, L10 and L12

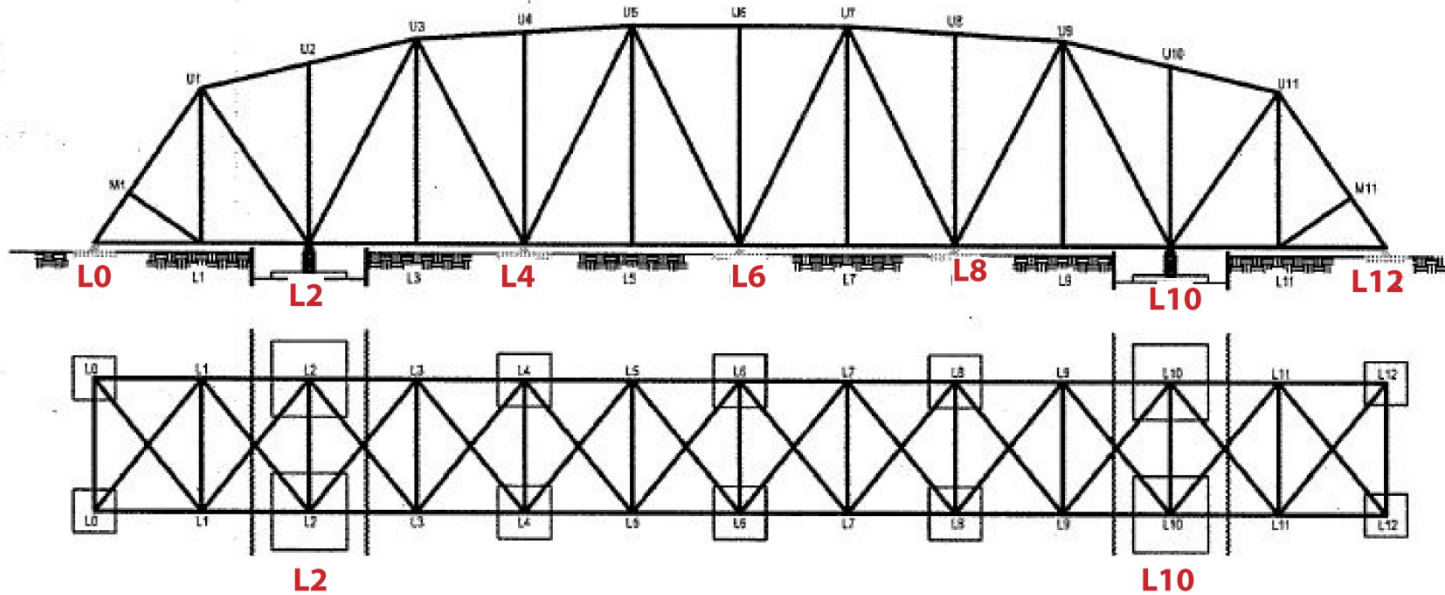


Figure 21: Truss supported on towers (at L2 and L10) for transport positioning

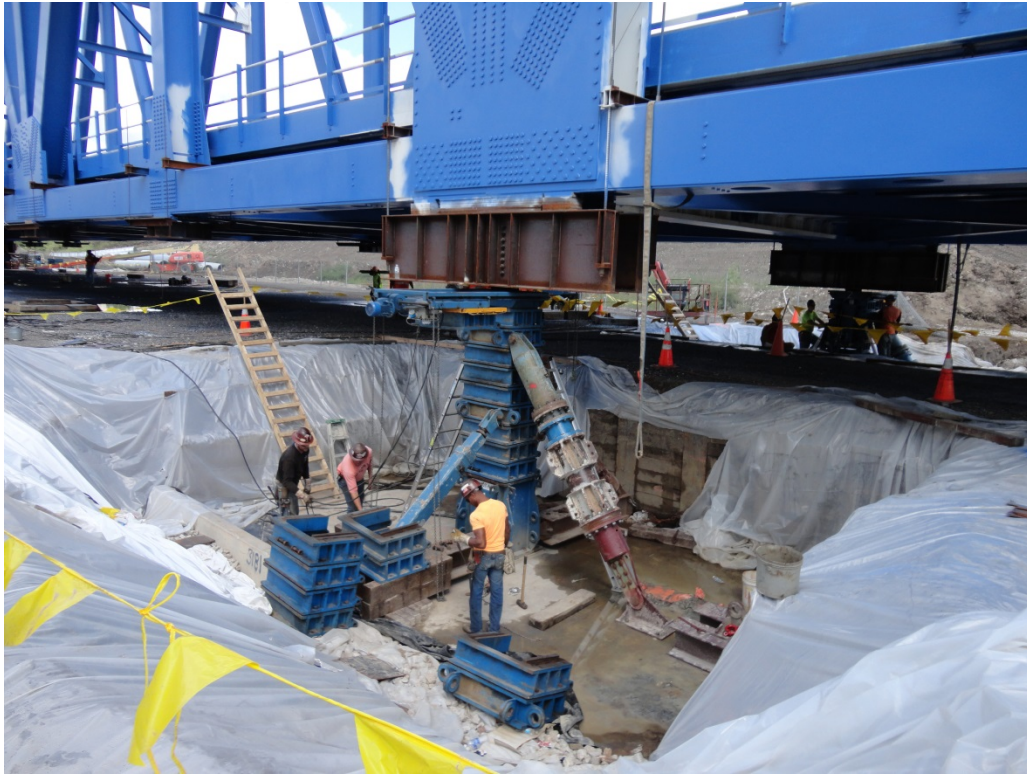


Figure 22: Jacking operation at L2



Figure 23: One of the two operators controlling the hydraulic jack operations



Figure 24: SPMTs at L3 and L4 and at L8 and L9

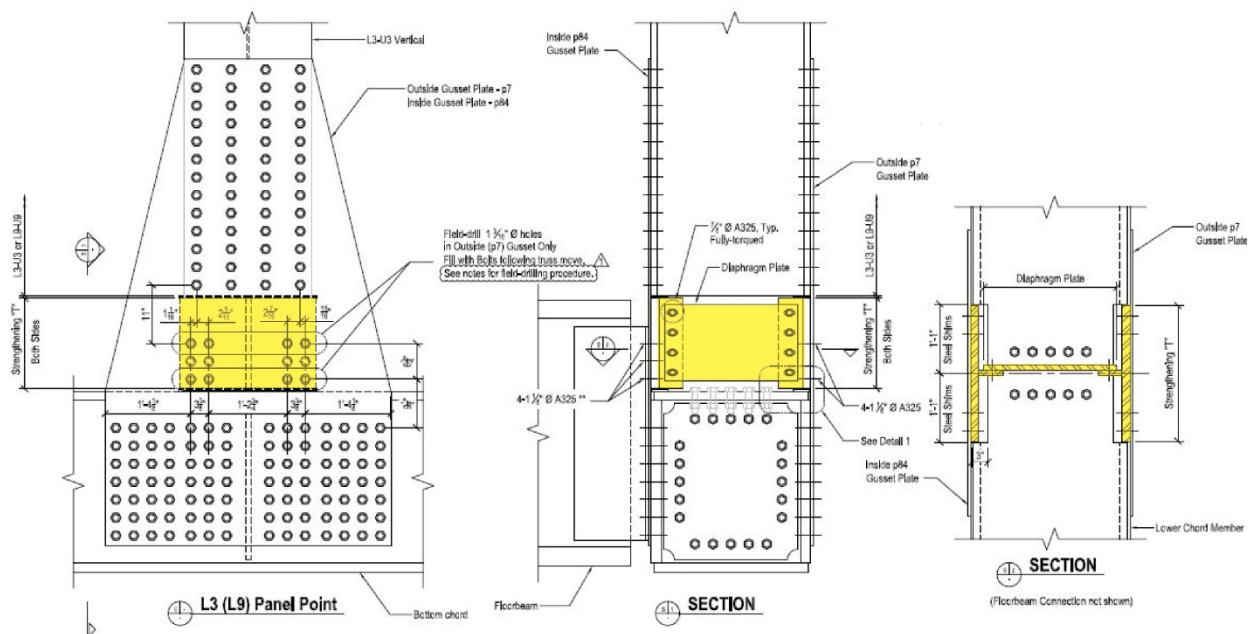


Figure 25: Joint strengthening at L3 and L9 (shaded areas) for support on SPMT's



Figure 26: SPMT at L3 and L4 and at L8 and L9



Figure 27: SPMTs moving truss over the existing NS tracks



Figure 28: SPMTs move truss towards its foundations (Mega Piers)



Figure 29: New truss alongside the existing bridge allowing commuter rail service to continue during assembly and installation of truss



Figure 30: October 25, 2012 - First NICTD Train Crossing Truss